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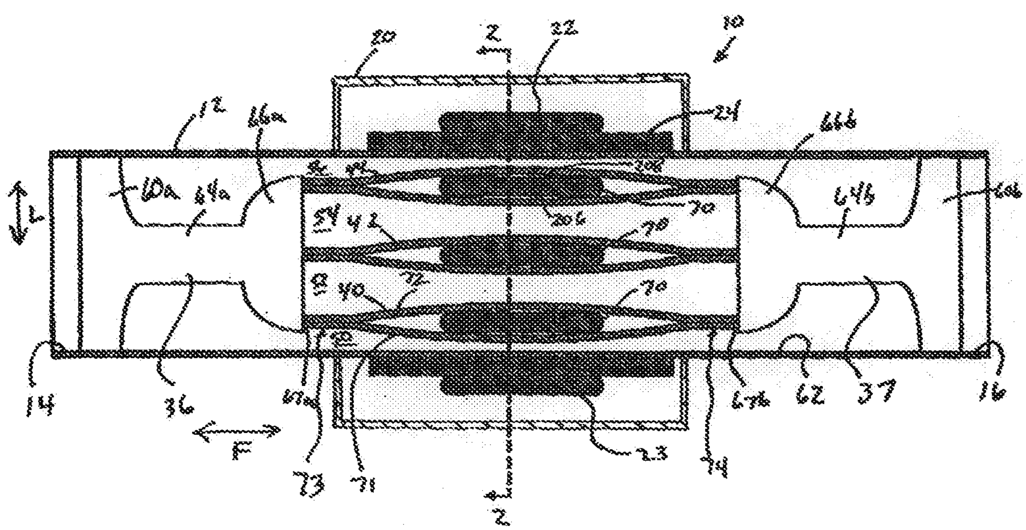

(57) Abstract

An apparatus and method of magnetically treating a fluid, particularly milk, include a conduit (12) with spaced apart elliptical plates (44) each holding a stack or a grid of magnets (70) having a common polarity direction and defining Venturi–shaped flow paths (50, 52, 54, 56) between plates. The method includes treating liquid milk product magnetically at process points upstream of equipment such as evaporators in the production of powdered milk from liquid milk. The treatment decreases scaling of heat exchangers and other equipment, as well as increases the protein content of the treated milk product.

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APPARATUS AND METHOD FOR MAGNETICALLY TREATING MILK PRODUCTS

Field of the Invention

The present invention relates to an apparatus and method for magnetically treating a fluid. Particularly, the invention relates to a mechanical component for treating a liquid by subjecting the liquid to a magnetic field. The invention is particularly useful in a method for treating milk with a magnetic field to prevent the deposition of calcium components on heat exchangers, evaporators and other equipment and to improve the protein yield of milk products.

Background of the Invention

In the processing of fluids, such as milk, the buildup of calcium scale on fluid processing equipment is a common problem which is experienced in many manufacturing processes especially those with heat exchange and fluids as an energy transfer medium. In the processing of milk and other food products rich in calcium, heat exchangers, vessels, piping, pumps and other equipment consistently build up a surface coating of scale which in many cases occludes the flow of fluid through the system as well as increases significantly the pressure drop through the system.

Apparatus for magnetically treating water are known. U.S. Patent No. 4,935,133 describes a magnetic treater for water for assisting in the removal of rust particles suspended in the water. U.S Patent No. 4,278,549 discloses a method and apparatus for magnetically treating liquid streams to reduce their tendency to deposit scales, and encrustasions. U.S. Patent No. 4,390,423 also discloses an apparatus with a magnetic treatment of water in order to prevent precipitation of dissolved substances and to reduce the corrosive effect of liquid on the conduits and service apparatus contacted thereby.

Magnetic treatment of water is known particularly for reducing scale, or treating water for improving the qualities of concrete. Magnetic treatment has heretofore not been applied to the processing of milk products. It would be desirable to produce a magnetic treatment apparatus suitable for treating milk products.

It would also be desirable to provide a magnetic treatment apparatus which provides for a low pressure drop while also adequately magentically treating the fluid flowing therethrough. It would also be desirable to produce a magnetic treatment device which is cost effectively manufactured and assembled.

Summary of the Invention

The present invention provides an apparatus and method for magnetically treating liquids, and particularly a method of treating milk products with a magnetic field. The apparatus of the invention includes a body within an encircling wall which includes an inlet and an outlet. Within the body are arranged magnet-supporting plates arranged in parallel and spaced apart across a transverse dimension of the body and extending in an axial direction. The plates are each formed as a sleeve or enclosure, and sized to tightly capture a plurality of magnets stacked in a vertical direction, perpendicular to the transverse direction. The magnets for each plate have a common magnetic polar direction aligned in the transverse direction and have faces of a common polarity arranged on one side of each plate and the opposite polarity arranged on the opposite side of each plate.

The plates are shaped to provide a Venturi-shaped flow path through the spacing between the plates, in an axial direction, e.g., in the flow direction between inlet and outlet. Thus, within each venturi-shaped flow path, the magnets on one plate have a first polarity and the magnets on the opposite facing plate have a second polarity opposite said first polarity.

As an additional aspect of the invention, external magnets are arranged spaced apart on an outside surface of the body, the external magnets in diametrical opposition having faces of opposite magnetic polarity. The magnets can be attached to a sleeve of magnetic material, the sleeve encircling the body. Also, each plate within the body may be shaped and sized to hold a plurality of magnets stacked in the axial as well as the vertical direction, forming a grid of magnets within each plate.

The magnets within the body are encapsulated by the plates which preferably are composed of 304, 316, or 316L stainless steel and polished to a number six finish. The plates each include sidewalls which are

inwardly curved toward axial ends (along the flow direction), and inwardly curved toward perpendicular ends (vertical ends). Preferably the plates are formed by flattening a pipe section to an elliptical shape, further flattening the ends and welding the ends closed.

The magnets are preferably sized and shaped according to one or more preselected uniform sizes and shapes for effectively reducing manufacturing costs. Thus, plates of a greater height, i.e., plates toward the center of the body, can be fitted with a greater quantity of uniform size magnets, without requiring a great variety of sized magnets for a wide range of plate heights. The magnets can be composed of a Crumax 3714 alloy.

In addition to the inventive construction of the magnetic treating device, the invention provides a method for magnetically treating milk heretofore unknown which has surprisingly beneficial results in the production of powdered milk from liquid milk. According to the method, the processing of liquid milk to powdered milk using a magnetic treatment in the process, improves the concentration of calcium in the milk product by keeping the calcium in solution, reduces chemical consumption for the cleaning of scale from evaporators and other heat exchange equipment, improves heat transfer within evaporators by minimizing scale buildup, and reduces environmental burden by minimizing the volume of acid and caustic required for cleaning the equipment.

Particularly, testing has shown an improvement in the protein concentration of milk over non-magnetically treated milk. By applying magnetic energy to the milk, a Faraday field causes the modification of calcium ions in solution and creates electrostatic attraction and enhancement of bonding between calcium cations and carbonate anions. This "early" nucleation and formation of $CaCO_3$ crystals inhibits the formation and remediates the production of calcium carbonate scale in and on milk evaporators, crystallizers, and heat exchange equipment.

Other features and advantages of the present invention shown will become readily apparent from the following detailed description, the accompanying drawings, and the appended claims.

Brief Description of the Drawings

Figure 1 is a longitudinal sectional view of a magnetic treating device of the present invention;

Figure 2 is a sectional view taken generally along plane 2-2 of Figure 1;

Figure 3 is a sectional view taken generally along plane 3-3 of Figure 1;

Figure 4 is a generalized block flow diagram of a milk processing method of the present invention;

Figure 5 is a longitudinal sectional view of an alternate embodiment of the present invention;

Figure 6 is a bottom perspective view of a magnetic 80 of the present invention;

Figure 7 is a sectional view taken generally along plane 7-7 of Figure 6;

Figure 8 is a sectional view taken generally along plane 8-8 of Figure 6; and

Figure 9 is a sectional view taken generally through plane 9-9 of Figure 6.

Detailed Description of the Preferred Embodiments

While the present invention is susceptible of embodiment in various forms, there is shown in the drawings and will hereinafter be described presently preferred embodiments with the understanding that the present disclosure is to be considered an exemplification of the invention and is not intended to limit the invention to the specific embodiments illustrated.

Figure 1 illustrates a magnetic treating device 10 which includes a body 12, such as a pipe, having a first open end 14 and a second open end 16. The first and second ends 14, 16 are shown as plain ends but can also be flanged end 6, screw threaded ends, weldable ends, or other connectable ends, for connecting the device into a piping system. Surrounding the body 12 is an external casing 20 in which is located at a first external magnet 22 and a second external magnet 23, arranged diametrically across the body 12. A sleeve 24 of magnetic material surrounds the body 12

between the first and second external magnets 22, 23. The external magnets 22, 23 are connected to the sleeve 24.

Within the body 12 are mounted horizontally disposed supporting brackets 36, 37 connected to a plurality of plates 40, 42, 44. The brackets 36, 37 laterally brace the plates 40, 42, 44 within the body 12. The plates 40, 42, 44 are spaced apart in a lateral direction L forming flow channels 50, 52, 54, 56. The plates 40, 42, 44 are contoured in a flow direction F such that the flow channels 50, 52, 54, 56 are substantially Venturi-shaped in the flow direction.

The support brackets 36, 37 are generally T-shaped having a transverse arm 60a, 60b connected to an inside surface 62 of the body 12, an axial bridge 64a, 64b and base portions 66a, 66b welded or otherwise connected to respective opposite ends 67a, 67b of each plate 40, 42, 44.

Each plate includes a plurality of encapsulated magnets 70a, 70b. The magnets 70a, 70b are stacked in a vertical direction as shown in Figure 3, and have a common polarity direction. The magnets 70a, 7b can be of a standard size and shape as shown in Figures 6-9. More magnets can be applied to taller plates, i.e., the central plates of the body 12. This can simplify the manufacturing, parts costs, and inventory costs.

The magnets 70a, 70b within each of the plates 40, 42, 44 are encapsulated by contoured side walls 71, 72 of each plate.

The plates 40, 42, 44 are advantageously manufactured by flattening circular tube stock in the lateral direction L and further flattening end regions 73, 74 and welding the end regions closed. The end regions 73, 74 are then welded to the brackets 36, 37.

Figure 2 illustrates the plates 40, 42, 44 containing the magnets 70a, 70b, the smaller magnets 70b located toward a top and bottom extremity within the plates 40, 42, 44. By using two different sized magnets 70a, 70b more magnets can be fit within the elliptical profiles of the plates 40, 42, 44 as seen in Figure 2.

As illustrated in Figure 2, within each plate 40, 42, 44 the magnets 70a, 70b have a common polarity direction, that is, as shown in Figure 2, the direction from south to north magnetic poles being left to right.

This is also true of the external magnets 22, 23 which have a same polarity direction, i.e., south to north magnetic poles being left to right.

The magnetic material sleeve 24 by being fastened to the external magnets 22, 23, will be polarized in two opposing arcs 24a, 24b as shown each arc for a distance approximately 120° of the entire 360° circumference. The external magnet 22 will polarize the magnetic plate arc 24a as a south pole and the external magnet 23 will polarize the magnetic plate arc 24b as a north pole The magnetic plate arc 24a is polarized as a south pole around that portion of the circumference which is opposed to the north pole of the plate 44 and that the magnetic plate arc 24b is polarized as a north pole opposing the south poles of the plate 40. Thus, each passage 50, 52, 54, 56 exposes the fluid flowing therethrough to a north polarity on a left side of the passage and a south polarity on the right side of the passage consistently.

Figure 4 illustrates, in block diagram schematic form, a milk processing plant 100 such as a plant for converting liquid milk to powdered milk. Plural magnetic treating devices are employed and indicated as 10a through 10f, sequentially, and each can be constructed as described above according to Figure 1 through 3 or as described below as the device 200 according to Figure 5 (described below), or any construction encompassed by the invention. The plant includes a feed pump 102 for delivering liquid milk through a first magnetic treating device 10a and through a filter press or heat exchanger 106. The liquid milk then is directed into a second device 10b and then into a pre-evaporator. Vapor is removed (not shown) and bottom liquid is removed from a bottom of the pre-evaporator 110 by a second pump 116.

The second pump 116 pumps the liquid through a third device 10c and into a first evaporator 120. Bottom liquid from the first evaporator 120 is removed by a third pump 126 and delivered into a fourth device 10d and then into a second evaporator 130. Bottom product is drawn by a fourth pump 136 and delivered into a fifth device 10e and into a third evaporator 140. Bottom product is drawn from the third evaporator 140 by a fifth pump 146.

The fifth pump 146 delivers the bottom product through a sixth device 10f and into a fourth evaporator 150. Bottom product from the fourth evaporator 150 is then transferred to a dryer.

Along the train of evaporators 110, 120, 130, 140, 150 the magnetic devices 10a, 10b, 10c, 10d, 10e, 10f treat milk of increasing solids content ranging between about 8% to about 55% solids. The magnetic device 10 is thus located in the process, upstream of each evaporator. In the milk processing industry, the heat exchangers or evaporators 110, 120, 130, 140, 150 are typically selected from exchangers such as LTVRF evaporators, or LTVFF evaporators. The magnetic treatment of the liquid milk product upstream of each evaporator assists in retaining proteins (calcium) during the evaporation process and prevents scaling on the heat exchange surfaces and in the equipment.

The devices 10a through 10f are all particularly designed for the process stream being treated. The number of plates, the size of the plates, can all be varied to minimize pressure drop through the device for hydraulic considerations, while maintaining adequate fluid velocity for magnetic treating considerations. For effective magnetic treatment, the fluid velocity should be greater than 5 feet per second. Each venturi typically has a minimum clear distances between adjacent plates of 1/8 inch to 1/4 inch. When sizing for velocity and pressure drop through the unit, the magnetic field is usually between 2500 and 6000 Gauss, typically 4000 to 5000 Gauss.

The magnetic energy (Faraday field) of the device causes the modification of calcium ions in solution and creates electrostatic attraction and enhancement of bonding between calcium cations and carbonate anions. This "early" nucleation and formation of $CaCO_3$ crystals inhibits the formation as well as remediates the production of calcium carbonate scale in and on milk evaporators, crystallizers, and heat exchange equipment. The magnetic energy also improves the concentration of calcium in the product by keeping the calcium in solution.

Table I demonstrates the surprising and beneficial result of using magnetic treatments of milk products in a process as shown in Figure 4. The crude protein improvement of the various test runs showed

remarkable improvement over the control group, non-magnetically treated test runs. The crude protein improvement in most cases was between three and five percent. The Table describes an analysis of magnetically treated test samples (1224, 1225, 1226, 1227, 1228, 1229, 1272, 1274, 1273) of the output of a powdered skim milk plant such as shown in Figure 4. The test samples are compared to non-magnetically treated control samples (1275, 1276). The chemical breakdown of the test samples shows no detrimental effect of the magnetic treatment of the milk product compared to the control samples.

The devices used in the test of Table 1 were similar to that shown in Figures 1 through 3 but without external magnets.

Figure 5 illustrates a magnetic treating device 200 which includes a body 212 such as a pipe having a first open end 214 and a second open end 216. The first and second ends 214, 216 are shown as plain ends but can also be flanged ends, screw threaded ends, welded ends, or other connectable ends for connection into a piping system. Surrounding the body 212 is an external casing 220 having an annular shape. Within the external casing 220 are located a plurality of magnets 224 arranged in rows of end-to-end magnets in the axial direction. As illustrated, the rows include three magnets per each row, two rows 230, 232 shown. The magnets 224 are shown having an elliptical shape (such as described in Figures 6 through 9). The magnets within each row have polarities arranged along a same direction. For example, in the row 230 the magnets are arranged with north side poles closest to the body 212 and the opposite row 232 has south side poles nearest to the body 212.

Within the body 212 are mounted horizontally disposed supporting brackets 236, 237 connected to a plurality of plates 240, 242, 244, 246. The brackets 236, 237 laterally brace the plates 240, 242, 244, 246.

The plates 240, 242, 244, 246 are spaced apart in a lateral direction L forming flow channels 250, 252, 254, 256, 258. The plates 240 through 246 are elliptically shaped in the flow direction F as shown in Figure 5.

As in Figure 2 the plates 240, 242, 244, 246 are connected by the support brackets 236, 237 substantially at a mid span of their overall heights. The support brackets 236, 237 are generally T-shaped having a transverse arm 260a, 260b connected to an inside surface 262 of the body 212, and axial bridge 264a, 264b and base portions 266a, 266b welded or otherwise connected to opposite axial ends of each plate 240 through 246. Each plate includes a plurality of encapsulated magnets 270a, 270b having a common polarity direction for each plate. The magnets 270a, 270b are stacked in an axial direction , or flow direction F as shown in Figure 5, and also in a vertical direction (not shown) as in Figure 3.

The magnets 270a, 270b can be of a standard size such as an elliptical shape as shown. More magnets can be applied to the taller plates, i.e., the central plates of the body 212. This simplifies the manufacturing and reduces manufacturing parts costs. As can be seen in Figure 5, the flow paths 250 through 258, due to the elliptical shape of the plates, provide a Venturi-shaped path in the axial direction. The Venturi-shaped path reduces presser drop in an axial direction through the device and can be sized and shaped to provide a sufficient velocity through the magnetic field.

The magnets 270a, 270b within each of the plates 240 through 246 are encapsulated by contoured side walls 271, 272 of the plates. Preferably, for a milk product treating apparatus, the plates are composed of 304, 316, or 316L stainless steel. The magnets are rare earth magnets of the type Crumax 3714 alloy.

Figures 6-9 illustrate the overall shape of the magnets 70a, 70b including generally elliptical profile 200 with flattened top and bottom regions 202, 204. The magnets 70a, 70b have a generally tabular profile throughout a width thereof having curved side walls 206, 208, as shown in Figure 7. The magnets 270a, 270b are similarly shaped. As demonstrated in Figure 3, the elliptical profile with flattened regions 202, 204 on top and bottom allow for compact packing of the magnets 70a, 70b within the plates 40, 42, 44.

The elliptical-shaped magnets as shown in Figures 6-9 can be incorporated into the arrangement of Figure 1 or Figure 5 for compact and dense packing of magnets within plates.

Although the embodiment of Figure 1 illustrates three plates and the embodiment of Figure 5 illustrates four plates, any number of plates from one to a number greater than four can be used depending on the size of the pipe and the desired flow characteristics within the body. Additionally, although the embodiment of Figure 1 illustrates a vertical stacking of magnets, it is encompassed by the invention that an axial stacking of magnets can also be used, forming a grid of magnets within each plate of the embodiment of Figure 1.

From the foregoing, it will observed that numerous modifications and variations can be effected without departing from the spirit and scope of the novel concept of the present invention. It is to be understood that no limitation with respect to the specific embodiments disclosed herein is intended or should be inferred. The disclosure is intended to cover by the appended claims all such modifications as fall within the scope of the claims.

TABLE 1

Sample No.		1224	1225	1226	1227	1228	1229	1272	1274	1273	1275	1276
Sample ID.		6/4 start	6/4 12pm	6/4 4pm	6/4 8pm	6/5 12am	6/5 4am	6/5 12pm	6/5 8:00a	6/5 3:45pm	New-1	New-2
Dry Matter %		95.45	95.45	94.69	93.93	94.36	94.67	95.67	95.51	96.32	95.35	96.04
Crude Protein %		34.38	34.92	34.83	34.89	35.19	35.25	33.5	33.42	33.2	33.72	33.12
T.D. N.												
Calcium %		1.14	1.1	1.1	1.1	1.08	1.12	1.07	1.08	1.08	1.09	1.09
Phosphorus %		0.99	1.04	1.04	1.03	1.05	1.09	0.99	1.01	1	0.97	1.02
Magnesium %		0.12	0.11	0.12	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.11
Potassium %		1.51	1.62	1.55	1.65	1.51	1.72	1.58	1.53	1.58	1.6	1.6
Copper ppm		1	<1	1	<1	<1	<1	2	1	1	1	1
Zinc ppm		36	36	38	37	37	37	40	38	37	36	36
Manganese ppm		1	1	1	1	<1	<1	1	1	1	1	1
% Fat		0.05	0.07	0.01	0.08	0.08	0.09	0.08	0.01	0.08	0.02	0.09
Total Protein												
Lactose %DS		57.8	59.1	56.8	57.8	55.1	57.1	55.3	54	58.4	58.5	56.3
Calcium %DS		0.77	0.73	0.66	0.75	0.66	0.67	0.42	0.61	0.52	0.67	0.67
Phosphate % DS		0.35	1.8	1.82	1.8	1.8	1.54	1.46	1.86	1.83	1.86	1.89
Riboflavin												
vitamin A												
pH		6.69	6.65	6.68	6.64	6.65	6.65	6.62	6.63	6.62	6.6	6.61
Ash ppm		7.79	7.67	7.53	7.64	7.54	7.51	7.46	7.44	7.42	7.47	7.48
Sulfate ppm		0.021	0.11	0.11	0.11	0.11	0.095	0.089	0.11	0.11	0.11	0.11
Chloride ppm		0.088	0.35	0.34	0.34	0.35	0.3	0.28	0.35	0.34	0.34	0.34
Nitrate ppm		0	0.081	0.078	0.08	0.08	0.081	0.082	0.08	0.08	0.08	0.08
Citrate ppm		0.31	1.35	1.35	1.38	1.39	1.22	1.14	1.38	1.46	1.39	1.39
Calcium %DS		0.77	0.73	0.66	0.75	0.68	0.67	0.42	0.61	0.52	0.67	0.67
Na %DS		0.42	0.51	0.5	0.39	0.38	0.35	1.38	1.11	1.63	1.31	0.76
K %DS		1.62	1.64	1.56	1.68	1.67	1.47	0.53	1.11	0.76	0.85	1.12
Mg %DS		0.12	0.12	0.11	0.12	0.12	0.11	0.1	0.11	0.11	0.11	0.11
Crude Protein Improvement		2.90%	4.50%	4.20%	4.40%	5.30%	5.50%	0.20%	n/a	n/a	control	control
based on samples compared to												
non-treated powder i.e. 1275,1276												

WHAT IS CLAIMED IS:

1. A method for treating milk product, comprising the steps of:

providing a container for containing milk product;

arranging a magnetic field through said container;

positioning the milk within said magnetic field.

2. The method according to claim 1, wherein said step of arranging said magnetic field through said container is further defined in that said container comprises a conduit, and the milk product flows through said conduit.

3. The method according to claim 2, wherein said step of arranging said magnetic fields through said conduit comprises the steps of:

arranging a plurality of magnets within said conduit.

4. The method according to claim 3, wherein said step of arranging said magnetic field through said conduit is further defined in that said magnets are encased inside plates that form a plurality of Venturi-shaped passages within said conduit.

5. The method according to claim 3, wherein said step of arranging said magnetic field through said conduit comprises the steps of:

arranging a plurality of magnets on an outside of said conduit.

6. The method according to claim 2, comprising the further step of heating said milk product to evaporate a liquid portion of said milk product after passing said milk product through said conduit.

7. A magnetic liquid treating device, comprising:

a surrounding wall having an inlet and an outlet and defining a fluid flow passage;

a plurality of magnets arranged within said flow passage, said magnets arranged stacked in a first row in a first direction transverse to a flow direction in said fluid flow passage, and arranged in a second row also stacked transverse to the flow direction in said first direction and spaced from and parallel to said first row, said magnets of said first row having a north polarity facing said second row, said magnets of said second row having a south polarity facing said first row.

8. The device according to claim 7, further comprising a plurality of magnets arranged in a third row stacked in a direction along the flow direction and a plurality of magnets arranged in a fourth row stacked in a direction along the flow direction and adjacent and parallel to said third row, said magnets of said third row have a north polarity facing said fourth row, said magnets of said fourth row having a south polarity facing said third row.

9. The device according to claim 8, wherein said magnets of said first and third rows are arranged within a first plate and said magnets of said second and fourth rows are arranged within a second plate, said first and second plates forming a Venturi-shaped passage therebetween.

10. The device according to claim 9 wherein said magnets have a thickness adapted to be contained within a profile of said plates.

11. The device of claim 7, further comprising external magnets arranged around and adjacent to said surrounding wall.

12. The device according to claim 7 comprising a plurality of plates arranged spaced apart and forming Venturi-shaped passages in the flow direction of said flow passage, one of said plates having said magnets of said first row arranged therein, and another of said plates having said magnets of said second row arranged therein.

13. The device according to claim 7, wherein said surrounding wall is cylindrical with a central axis, and comprising a plurality of plates, each plate containing a grid of magnets with north polarity facing a common direction, said plates are arranged in parallel, spaced-apart across a diameter of said cylindrical surrounding wall, said plates having a profile along said flow direction to create Venturi-shaped passages between plates.

14. The device according to claim 13, further comprising external magnets mounted on an outside of said cylindrical wall.

15. The device according to claim 13 further comprising a support bracket extending in an axial direction and connecting a central group of said plates together at a mid height thereof.

16. A magnetic treating device for fluid, comprising:

a surrounding wall having an inside surface, an inlet and an outlet and a flow direction from said inlet to said outlet;

a plurality of plates arranged in spaced apart fashion within said wall, each of said plates having a plurality of magnets stacked along a first direction perpendicular to said flow direction within said wall, said magnets in each plate having a common polarity facing toward an adjacent plate.

17. The device according to claim 16, wherein at least some of said plates are contoured in an axial direction to form Venturi-shaped flow paths along said flow direction.

18. The device according to claim 16, wherein said magnets in all of said plates have a common polarity direction.

19. The device according to claim 16 further comprising a plurality of magnets mounted to an outside of said surrounding wall and having a common polarity direction.

20. A magnetic treating device for fluid, comprising:

a surrounding wall having an inside surface, an inlet and an outlet and a flow direction from said inlet to said outlet;

a plurality of magnet assemblies arranged spaced-apart within said surrounding wall and forming venturi-shaped flow paths between said assemblies in said flow direction.

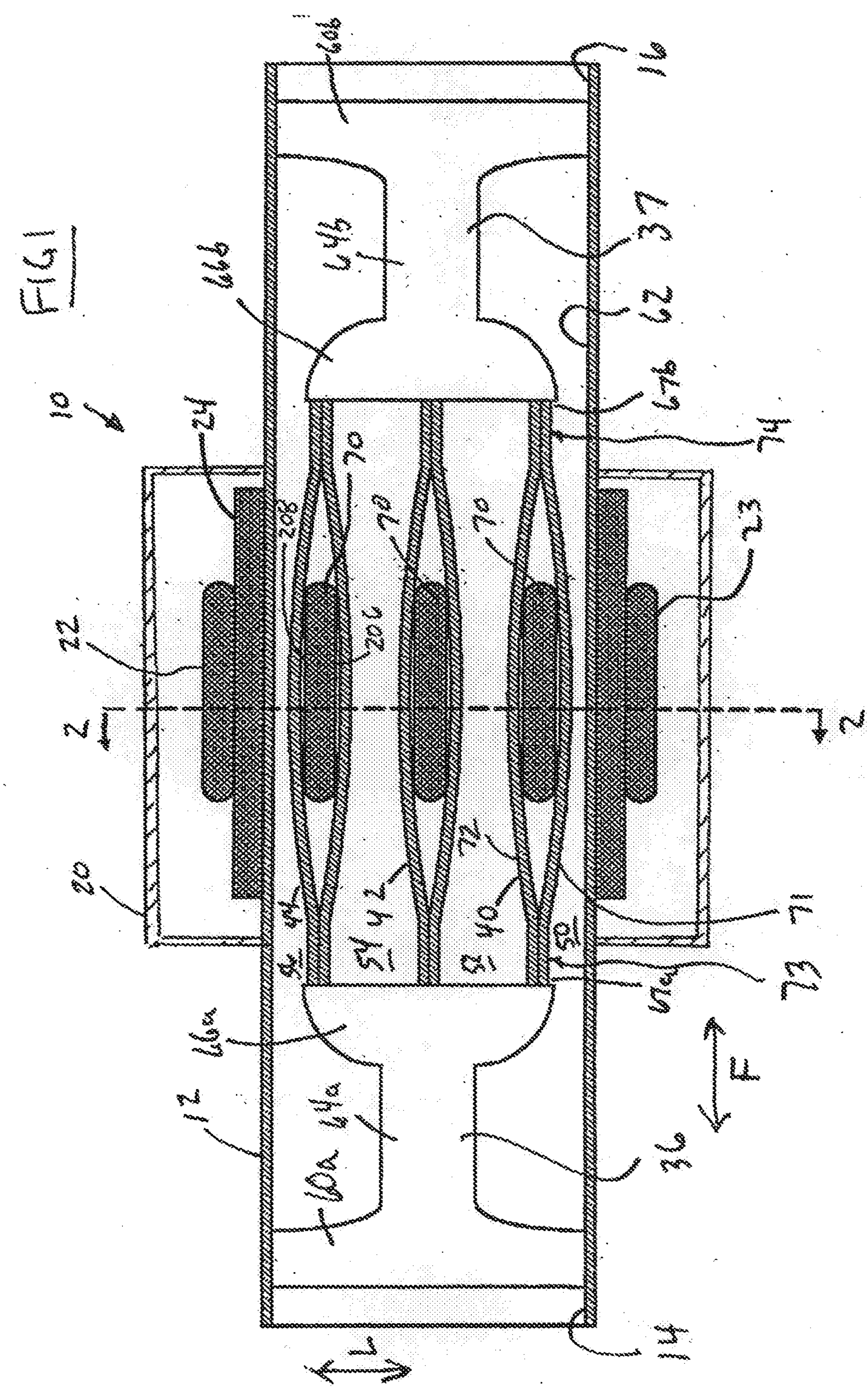


FIG 1
10
12
14
16
20
22
23
24
36
37
40
42
44a
44b
62
66a
66b
67b
70
71
72
73
74
2
2
L
F

FIG 2

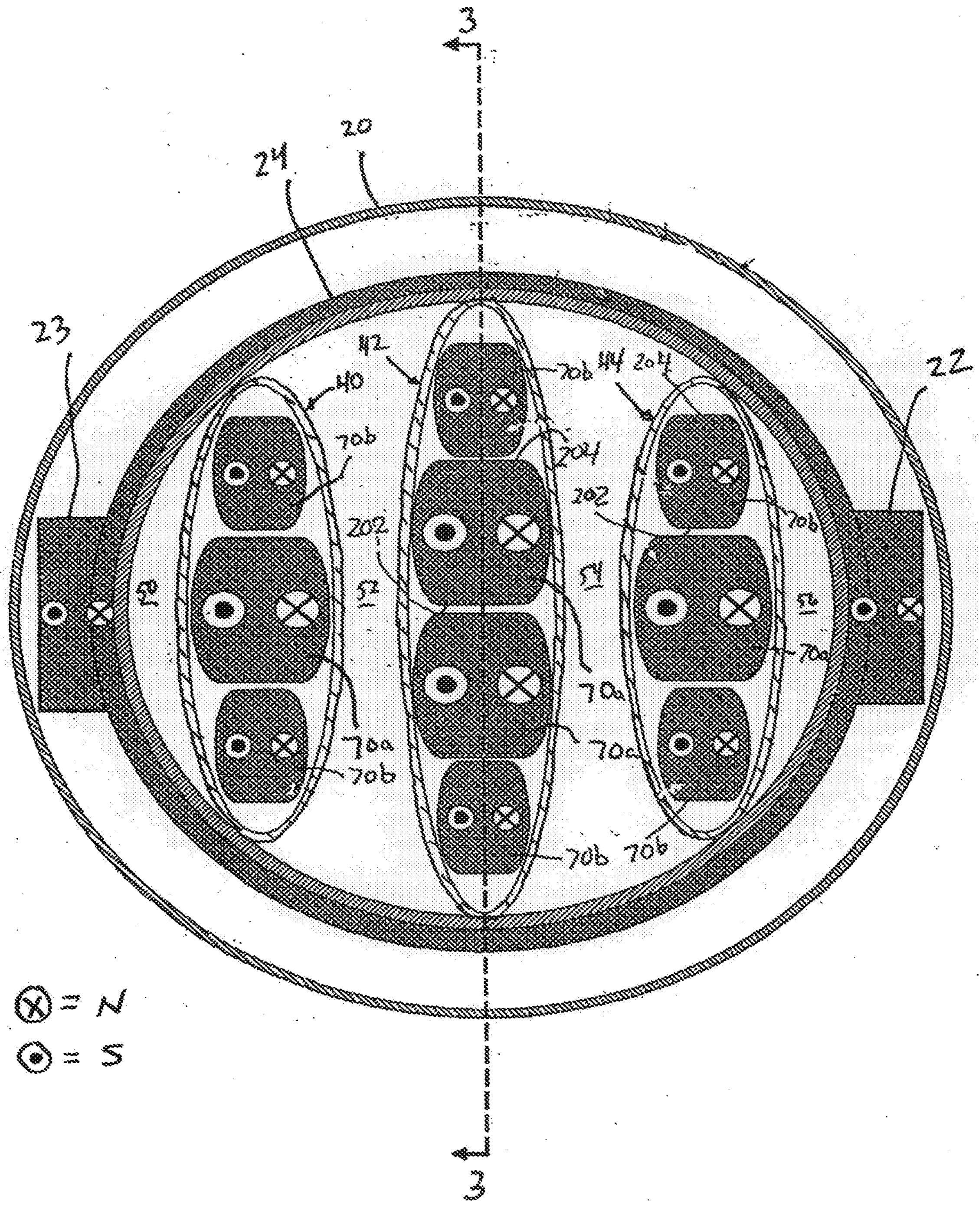
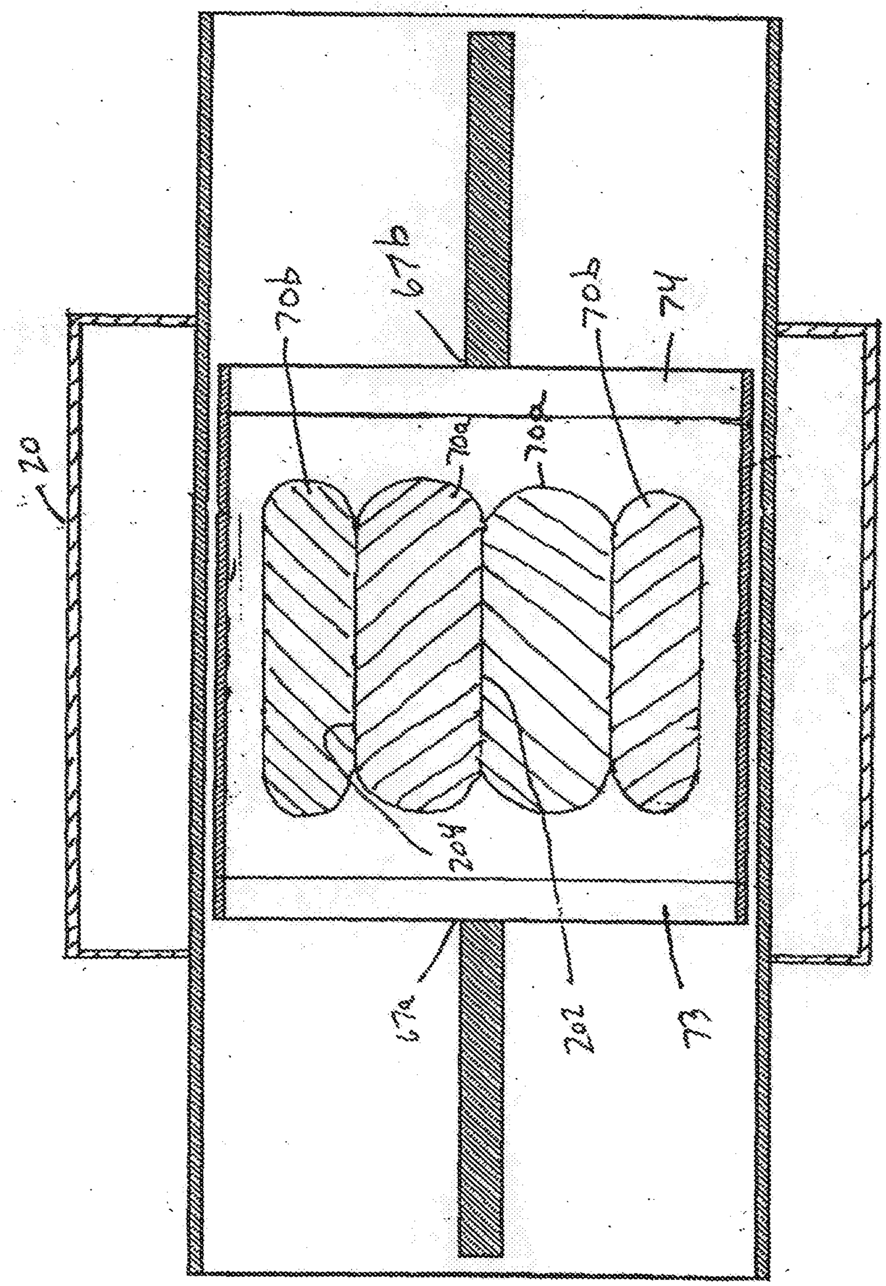


FIG 3



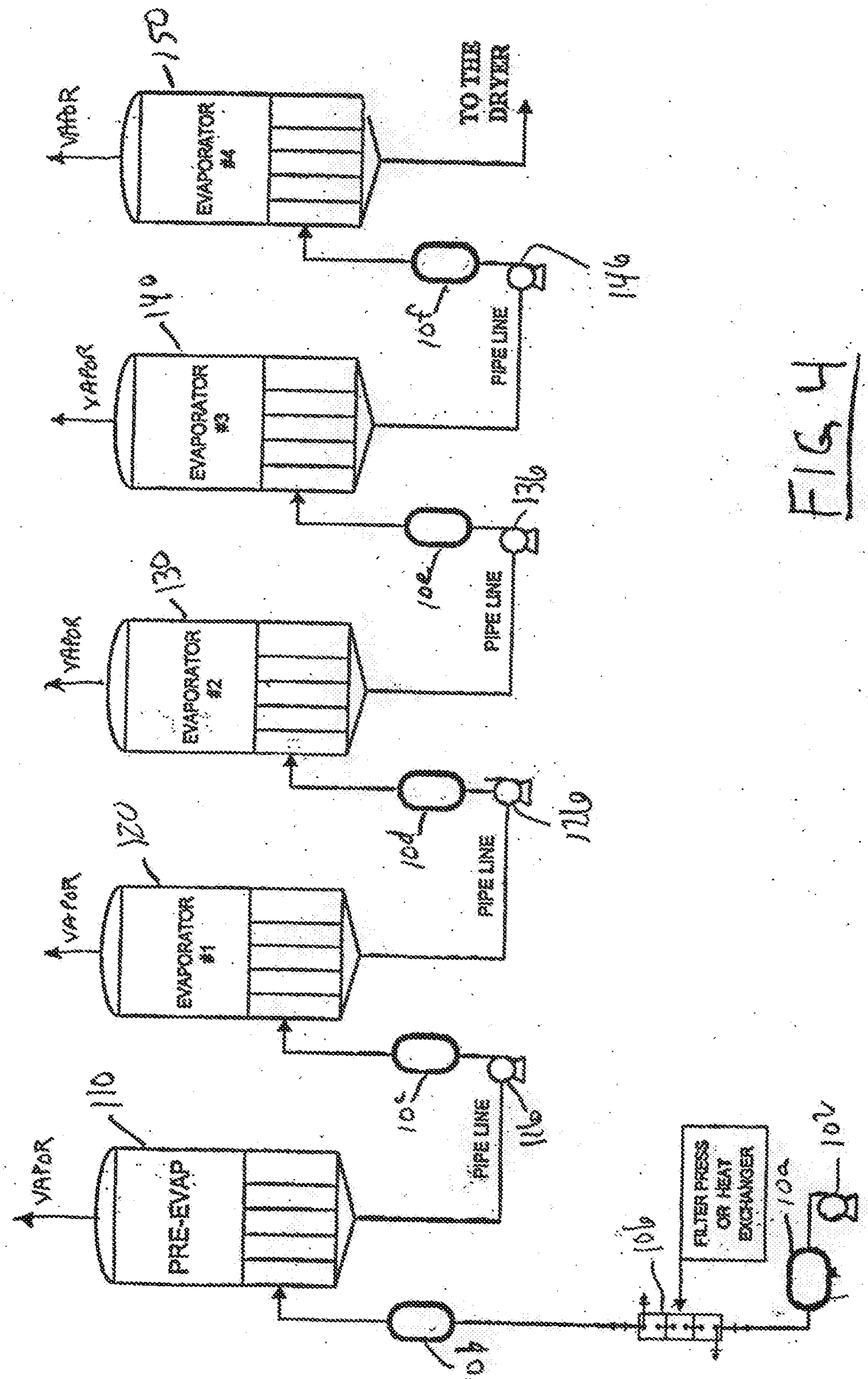

VAPOR
PRE-EVAP
110
EVAPORATOR #1
120
EVAPORATOR #2
130
EVAPORATOR #3
140
EVAPORATOR #4
150
TO THE DRYER
PIPE LINE
FILTER PRESS OR HEAT EXCHANGER

FIG 4

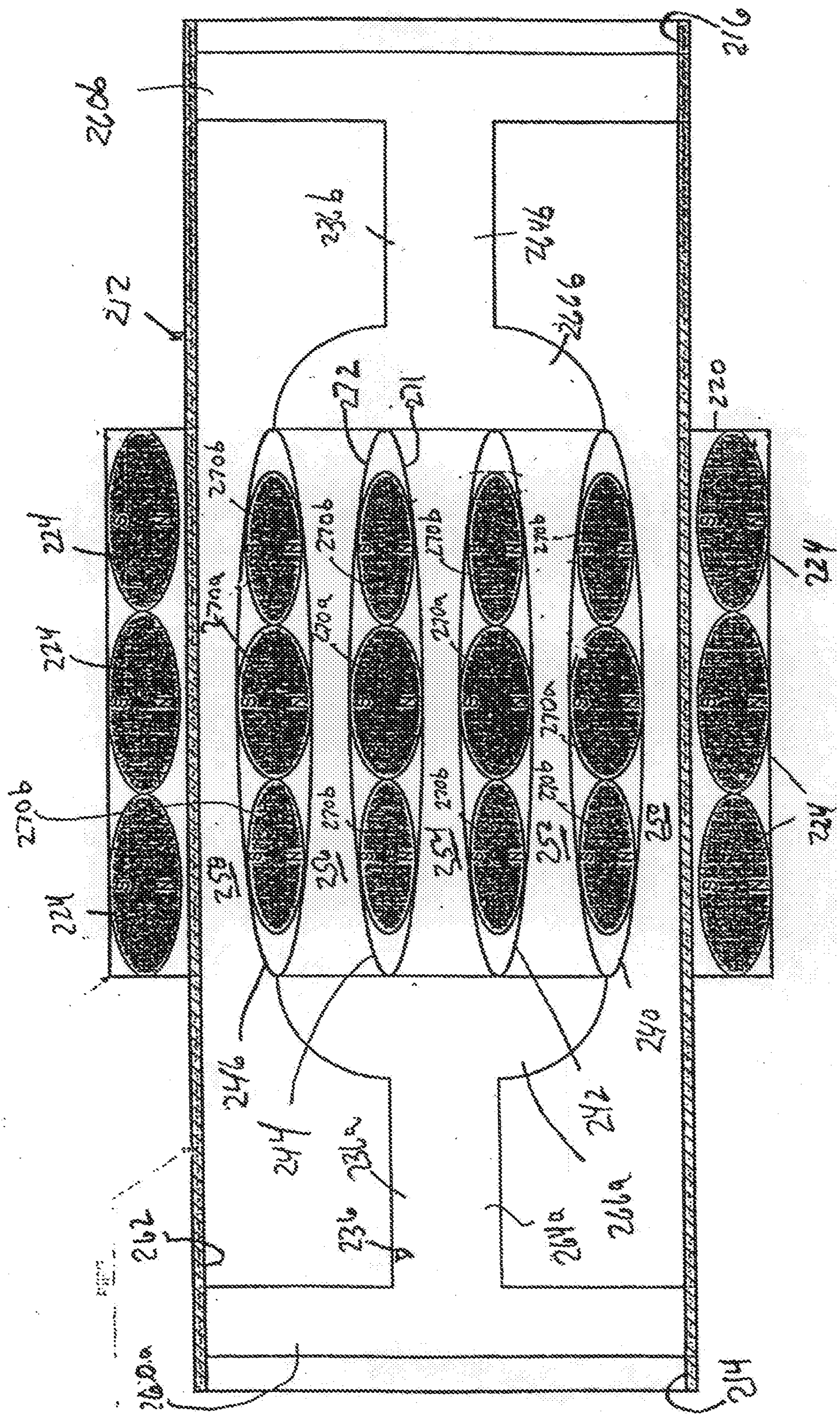

260b
216
212
236b
246b
266b
272
271
220
224
270a
270b
258
256
254
252
250
246
244
242
240
236a
266a
264a
262
260a
214

FIG 5

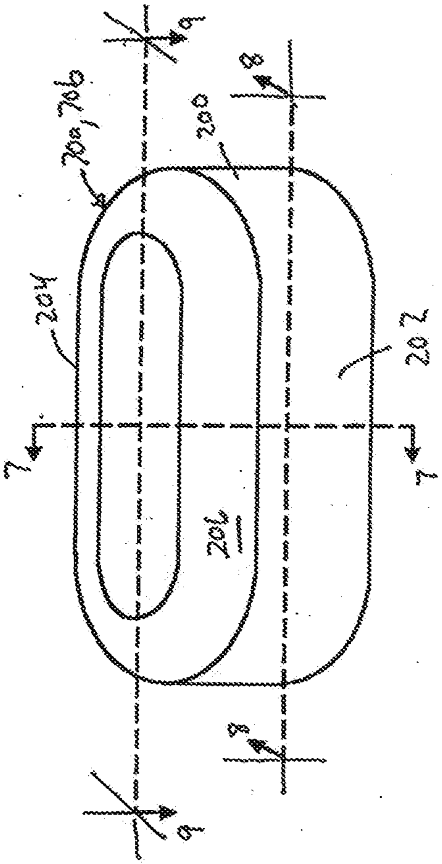


FIG 6

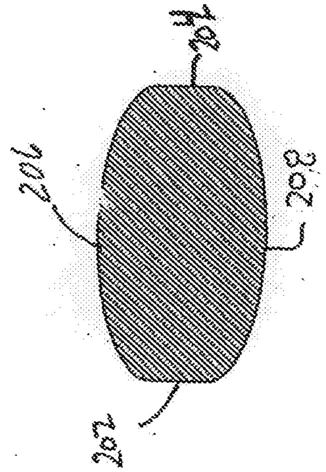


FIG 7

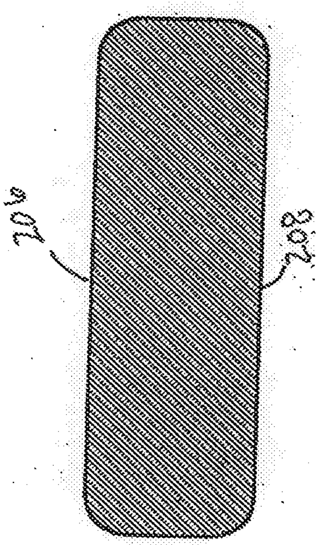


FIG 8

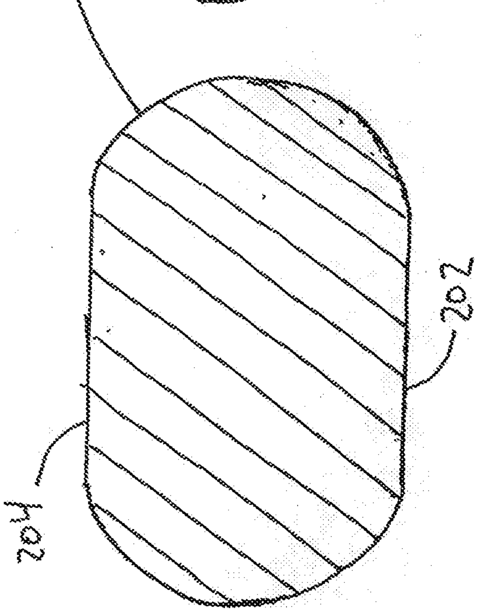


FIG 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/15805

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :A23C 1/00, 9/00, 9/14
US CL :426/237, 471, 520, 522; 210/222, 695
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/237, 471, 520, 522; 210/222, 695

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,589,065 A(BOGATIN ET AL) 31 December 1996 (31-12-96), see column 1, paragraph 2 and column 5, paragraph 4 and Figures 1 and 5).	1-20
Y	US 4,999,106 A (SCHINDLER) 12 March 1991 (12-03-91), see column 1, paragraph 2 and column 2, paragraph 10 and Figure 2.	1-20
Y	US 4,278,549 A (ABRAMS ET AL) 14 July 1981 (14-07-81), see column 1, paragraphs 1 and 2.	1-20
Y	US 4,390,423 A (SUNDT) 28 June 1983 (28-06-83), see column 1, paragraph 1 and Figures 2, 3 and 6.	1-20
Y	US 4,935,133 A (HIRAMA) 19 June 1990 (19-06-90), see column 1, paragraph and Figure 14.	1-20

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 NOVEMBER 1998	17 DEC 1998

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Steven Weinstein Telephone No. (703) 308-0651

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/15805

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Brief communications of the XXIII International Dairy Congress, Montreal 8-12, October 1990, vol. II, p. 329. "The influence of Magnetic Field on the formation of milk stone and crystallization of Lactose". (BEGLARIAN ET AL), Dialog Abstract.	1-20
Y	Prumysl Potravin vol. 30 (11):P.632-633, 1979. (CHLADEK) Dialog Abstract.	1-20
Y	Journal of Dairying Foods and Home Sciences 14(4):P171-180, 1995 (ANEJA ET AL) Dialog Abstract.	1-20
Y	Dairy Industries International 1996, 61(4) 15, 17 (GRANDISON) Dialog Abstract.	1-20
Y	SU, A, 523,682 (MARSHALKIN ET AL) 1976 Dialog Abstract.	1-20
Y	American Diary Review vol. 43(1) P. 186, 1981, Dialog Abstract.	1-20